

Social and environmental risk factors associated with county-level asthma emergency department visits

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Background

Asthma is a chronic condition affecting an estimated 22.6 million people in the U.S. Exacerbation of asthma symptoms caused by exposure to triggers or poor asthma management can lead to emergency department (ED) visits. County-level rates of asthma ED visits vary significantly. Using data from the [CDC's Tracking Network](#) and the [CDC's Social Vulnerability Index](#) we sought to better understand geographic variation in asthma ED visits and to identify factors contributing to that variation.

Methods

Study Area

22 States participating in the CDC Tracking Network's data exchange program:



Data

County-level (2008-2012)

- Asthma emergency department visit standardized incidence ratios (SIR) (L_{ij})
- Median 24-hour average $PM_{2.5}$ (PM)
- Median 8-hour max Ozone (o_3)
- Maximum daily temperature, (MAXF)
- Percent uninsured, 2010 (PERUN)
- The CDC's Social Vulnerability Index, 2010 (SVI)
 - Socioeconomic status
 - Household composition
 - Minority status & language
 - Housing & transportation

Bayesian Hierarchical Modeling

$$L_{ij} = B_1 * SVI_{ij} + B_2 * PM_{ij} + B_3 * o3_{ij} + B_4 * MAXF_{ij} + B_5 * PERUN_{ij} + v_{ij} \quad [1]$$

$$v_{ij} \sim N(B0_j, \sigma_j^2)$$

with hyperpriors

$$B0_j \sim N(\mu_{B0}, \gamma_{B0}^2)$$

$$\sigma_j \sim Uniform(0, 100)$$

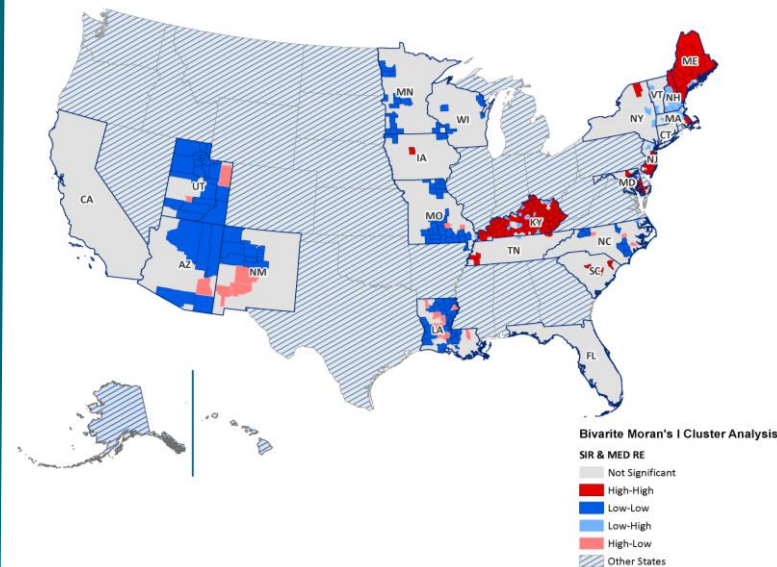
and

$$\mu_{B0} \sim N(0, 100000)$$

$$\gamma_{B0} \sim Uniform(0, 100)$$

- Models fit with Bayesian Monte Carlo Markov Chain methods using hierarchical mixed methods to control for state and county clustering
- The natural log of the observed SIRs: L_{ij} , is modeled as the outcome of interest [1]
- $B0_j$ is the random intercept for state j with σ_j^2 showing state-specific residual variation
- μ_{B0} corresponds to the mean state-level effects & γ_{B0} reflects variation among state intercepts
- Deviance Information Criteria (DIC) and estimated posterior distributions used to assess model fit
 - SVI alone versus with additional risk factors
 - No random effects, state only, county only, or state and county random effects

Spatial Analysis



- Results from a bivariate Local Moran's I comparing SIRs to the spatial lag of Median Random Effects Residuals
- Clustering indicates there are additional covariates contributing to spatial patterns that we didn't include in our model due to limited data availability

Results

- The model containing only SVI with state and county random effects provided the best fit to the data.
- We estimate a **12 to 16 percent increase in asthma ED visits for every increase in one unit of SVI** at the county level.
- The estimated posterior distributions for the other covariates were centered on zero and were not meaningful.
- After accounting for state & county random effects, we observed no meaningful difference in impact of SVI by state.
- Our spatial analysis of the random effects residuals suggests our model does not fully explain geographic variability in asthma ED visit rates (additional contributing variables not included in analysis).

Limitations

- Our results apply to county-level asthma ED visits and should not be applied at the individual level.
- Cross sectional are merely estimates of the complex issue of social vulnerability. There are likely additional place-based factors contributing to community level social vulnerability not included in SVI estimates.
- We did not include additional factors known to be associated with asthma ED visits at the individual level such as smoking and indoor air quality as a potential covariates due a lack of data.
- County level data including $PM_{2.5}$, ozone, and daily maximum temperature may not be at a fine enough geographic scale to reflect true variation in air pollution and temperature.

Conclusion

The CDC's Social Vulnerability Index is a strong predictor of county-level variation in asthma ED visits at the county-level among tracking states. While daily fluctuations in $PM_{2.5}$ and O_3 are associated with asthma ED visits, variability in county average annual concentrations do not contribute to variability in county SIR. Additional analysis should include an assessment into the specific social risk factors associated most strongly with asthma ED visit rates.

Takeaways

- SVI is a significant predictor of county-level asthma ED visits.
- However, SVI does not explain all the variability in county-level asthma ED visits.
- Spatial clustering still exists after accounting for SVI.

This study is one of the first attempts at exploring SVI data in the context of chronic disease. Understanding the relationship between social vulnerability and asthma ED visits can aid the development and implementation of public health actions to reduce the occurrence of asthma ED visits.

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